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Practical Examples and Future Needs for Computer Assisted Exercises at the Operational Level of Military Decision Making

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Summary

Computer assisted exercises have developed over the last ten years into the most cost-effective method to perform collective headquarters training in NATO. Considerable advance has been made to support the concept of "train as you fight or operate" by achieving close integration between simulation environments and command and control information systems. Key factors for the success of CAXes are the selected simulation, the level of training and competence of exercise planners and support personnel and the ability to mediate effectively between simulation and CCIS used by the exercising headquarters. For operational level exercises, the Joint Theater Level Simulation was selected as the preferred exercise driver. Effective methods for exercise planner training and simulation data base development have been developed combining clearly defined organisational concepts and tools. The methods of training have been refined but remain manpower intensive. Exercise management has been addressed more recently and is showing great potential for effective formalisation and support. Based on current practice and technological investigations, future avenues that will contribute significantly to this field are simulation composability through interoperability, advanced distributed learning and highly flexible data collection and analysis.

1 Introduction

The mission of NC3A's CAX project is to support NATO's Allied Command Europe (ACE) in the specification, development, implementation and evolution of a training and exercising organisation. This organisation will make use of the most advanced methods and tools available to perform its tasks of individual and collective training and exercising. Hence the emphasis on assistance by automated systems in the preparation, conduct, observation and analysis of training events.

An evolutionary methodology of systems development is applied which relies heavily on user participation and experimentation. Methods of organisation and work and supporting tools are developed and tested in a laboratory environment. Sufficiently successful prototype capabilities are subsequently applied during exercises. This phase of field testing is essential in evaluating capabilities with a broad user set under realistic performance conditions. The empirical data that can be gathered in this manner, forms the basis for the acquisition process of capabilities that will meet user requirements and will be able to continue to evolve.

The CAX development within ACE has gone through a process of laboratory development from 1991 to 1994, followed by extensive field testing from 1995 to 1999 and is currently transitioning into the acquisition of an initial capability through the creation of an ACE training organisation called the ACE Command and Staff Training Programme (ACSTP). Subsequently the organisational methods and supporting tools will evolve through short development, test and acquisition cycles.

This document describes the practice of computer assisted exercising that has been developed through the evolutionary process described above. The critical factors that determine the success of any simulation-

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driven exercising capability are introduced. The rationale for selecting the current model of choice for ACE and the associated management approach are discussed. Considerable effort has been expended on defining and refining an effective exercise preparation methodology and supporting tools. Current practice is discussed. In addition to simulation models, effective mediation with C2 systems employed by staffs during exercises is essential in achieving an environment that enables “to train as you fight”. Proven methods and approaches will be highlighted. Finally, some major technological areas that can contribute to the evolution of a cost-effective CAX capability for ACE and NATO will be discussed briefly.

2 Overview and CAX critical success factors

In planning a CAX, it is critical to identify and describe the training audience in terms of their objectives. A clear definition of objectives in a co-ordinated manner among and within headquarters is essential in developing the expectation of the nature and of the results of the exercise. NC3A’s CAX experts participate directly in the planning process of computer assisted exercises to ensure that achievable objectives are set and to inform exercise planners, participants and command groups of the capabilities and limitations of automated exercise support tools. This aspect of the planning process grows in importance with the number of headquarters involved in the exercise.

Having decided upon achievable objectives, the design of an effective information systems architecture that combines the simulation environment and the headquarters operating environment into a representative information management environment is critical. Locations, from which the training audience will be operating and the tools and systems that they intend to employ to communicate with their commanding and subordinate echelons, need to be considered. This aspect will have a direct influence on the nature of the communications systems that are used to enable data flow. The various options for the location of response cells to the lowest decision level of the training audience and the ability to provide automated interfaces from the CAX environment can be derived from this decision. Overall location decisions constitute an important cost driver for exercises and are therefore a critical aspect of the CAX planning process.

During a CAX, the real world is replaced by a simulated world. The simulated world’s state, content and behaviour are defined by a combination of data and logic. The data is contained in the databases that form the input for the simulation(s) that contain the logic. Therefore it is necessary to ensure a direct involvement with:

(1) the development path and the developers of the simulation model(s) that are used for CAXes

(2) the definition of the data that is entered into the simulations.

Indeed, the data describing the simulated world needs to be a sufficient reflection of that part of the real world that is simulated to meet the exercise objectives. Since the objectives vary from exercise to exercise, this is an on-going task. In order to ensure formal participation by all parties involved in the process and allocation of sufficient effort, NC3A has introduced the concept of a CAX data base management team. The team combines representatives from the participating headquarters, simulation database experts and others who can contribute relevant knowledge e.g. geo officers, weapon system specialists etc. Each participating headquarters formally appoints a member of this team. They are trained by the CAX experts in the data requirements and the logic that the simulation applies to the data. The headquarters members tend to become CAX environment experts and need to become a part of the CAX management cell during the conduct of the exercise.

From an information systems architecture point of view, it must also be noted that data base building is inherently a distributed activity. The necessary means in terms of communication systems, data construction and review tools and data validation tools need to be available to support this way of working.

The simulation model or federation of models that supports a CAX consumes the data that has been built and can portray certain behaviours over time. It is a reduction of the real world and therefore will have limitations. On the other hand, automated simulations are very powerful in showing the impact of the environment, of limited perception of truth and of logistic constraints on the ability of units and entities to perform their

missions. This is especially true when the environment is complex, the number of entities represented is large and their nature is diverse. If provided with good data, automated simulations can provide a consistent behaviour of entities and environment over time that cannot be achieved through other means.

Response cells constitute another critical element in a CAX. One or multiple response cells will communicate with a headquarters staff. Therefore a response cell must be viewed as a set of people and systems that communicate with the training audience as well as with the simulation environment. They must be able to provide relevant information to the training staffs and interpret their decisions in a realistic manner. Therefore they need to combine military and simulation knowledge. As a cell, they represent all the subordinate echelons below the training audience. Since the simulation environment may not be representing entities at a level of resolution that corresponds to the level directly below the training audience, a response cell must be able to develop plans and aggregate information over multiple echelons.

A response cell acting as a subordinate or another agency that exchanges information with the training audience may also introduce scripted events i.e. not simulated, in the sequence of simulated events when the circumstances are appropriate to meet specific training objectives. Ensuring a logical flow of events and a correct synchronisation is crucial when mixing scripted and simulated events. In view of the growing importance and reliance on automated CCIS interfaces, a function of response cells is increasingly being fulfilled by automated interfaces. These tools will generate data in a form that can be processed by the command and control systems used by the training audience and consume suitably formalized tasking from exercising staff.

Effective tools of the exercise directing staff are constituted by the cells representing the opposing and other forces that play an active role in the simulation database. These cells are tasked by the directing staff to achieve certain objectives. In order to increase exercise cost-effectiveness, professional cells employing powerful order entry tools are used to perform these functions. Another possibility is to oppose headquarters to each other. In this case, the structure of headquarters and response cell is mirrored. Small-scale exercises of this nature have been executed successfully.

Finally, the core planning team of the exercise must understand the above factors to perform its planning task. The team will also act as the main directing staff during the execution of the exercise. Therefore it is essential that this team receive sufficient knowledge about each of the exercise components. During the exercise, they must be capable of performing the following tasks:

(1) assessing the state of the exercise with respect to the achievement of exercise objectives

(2) determining effective measures to steer the exercise in the required direction e.g. by introducing external constraints like unexpected weather conditions

(3) understanding the factors that have contributed to the current state of the exercise.

These tasks require a lot of detailed information to be gathered and aggregated and a deep understanding of all CAX elements. Therefore CAX experts on each of the elements are assembled in a CAX management team during the exercise and are co-located with the main directing staff element. In view of the regular turnover of personnel, the knowledge transfer function to ensure that exercise planners are suitably trained to perform their function is essential.

It is also essential to consider the operational constraints that will influence the manner in which the CAX capability will operate. Affordable manning levels, funding for preparation and execution should be scoped prior to the selection of an exercise environment. Particularly the augmentation levels required for exercise execution can be prohibitive. Experience in NATO has also shown that professional support for response cells and communications assets to support distributed exercises in a robust manner are major cost drivers.

From an infrastructure point of view, the ability and need to achieve networking with C2 systems needs to be established. The ability to re-use existing communications infrastructure and support personnel is advisable. An approach concerning the provision of exercise-related expertise has to be selected. Indeed given the complexity of current exercise environments, the investment in acquiring subject-matter expertise is non-negligible. When selected, the personnel should be maintained in their role for a length of time that allows their

knowledge to be applied sufficiently frequently and to be passed on when personnel transitions to other functions. In view of the regular rotations of functions in military organisations, this last aspect requires a well defined human resource management approach.

3 The CAX Model of Choice for Operational Level of Military Decision Making and evolutionary approaches

NC3A supports ACE in the selection of suitable simulation environments for its various and evolving exercising requirements. NC3A is also actively involved in guiding the evolution of these environments by capturing changing requirements, expanding current capabilities and fostering national or multi-national efforts. In this context, NC3A's CAX project manages changes to the Joint Theater Level Simulation (JTLS) and directs pathfinder activities in the area of multi-national simulation interoperability for exercises.

Complex simulation models contain a wide representation of entities and logical rules that describe the characteristics of real world objects and their behaviours. Hence designing the appropriate data to feed simulations and developing cost-effective modes of utilisation that meet organisational constraints, require an investment in time and the commitment of personnel resources to acquire the necessary expertise. Reusing a simulation environment for multiple exercises will increase the return on this investment. Therefore SHAPE decided to select a simulation environment for its operational-level exercises and to develop a small knowledge base to manage and maintain its investment at NC3A.

The principal factors that led to the selection of the JTLS model were:

(1) Its ability to simulate joint and combined operations including logistics and intelligence aspects at a level of detail commensurate with the intended training audience. The level of detail required by the various training audiences in NATO was identified using the level of detail of information required by the lowest levels of exercising staffs.

(2) The unclassified nature of its algorithms enables its application for exercises at various levels of classification in a NATO and PfP context.

(3) The lack of embedded data in the simulation code that enables multi-national systems and capabilities to be defined and configured by the model operators rather than by its developers or configuration managers.

(4) Its affordability in terms of licensing and operating cost.

(5) The acceptance by the model management organisation of SHAPE as a voting and contributing member in the development of the simulation.

As a member of the JTLS configuration control board, SHAPE participates in the yearly prioritisation of trends for modification and enhancements to the model. NC3A, as its technical agent, co-ordinates the inputs of suggested modifications throughout ACE commands and introduces them in the formal configuration controlled change process of the model. Specific modifications that are of high importance to SHAPE and cannot be funded by the configuration control authority are funded separately. Their implementation is managed by NC3A in close co-ordination with the configuration control authority.

In addition to the management of the JTLS model, SHAPE has fostered the co-operation between NATO nations in the CAX area by establishing an advisory multi-national working group. This group has enabled SHAPE to remain fully informed of national developments and has enabled new operational requirements to be presented and discussed. These interactions have resulted in the experimentation with multi-national federations of simulations based on various simulation interoperability protocols. The collaborative work has contributed to the development of a NATO-wide modelling and simulation (M&S) master plan and the establishment of a NATO M&S group. A sub-group has been initiated that addresses CAX matters specifically. This group, the NATO simulation advisory task group on CAX, has subsumed the work of SHAPE's multi-national working group and is chaired by NC3A. Simulation interoperability is currently perceived as

the most cost-effective method of enhancing exercising environments. Particularly, combining proven exercise simulations to meet emerging exercise requirements allows user confidence to be maintained and reduces technical as well as exercise operational risk. However it must be recognised that this approach will require greater emphasis and resources for interoperability protocol management and evolution as well as for federation compliance testing. It also needs to be understood that interoperability in a multi-national context requires a sustained and substantial commitment by the participating nations and institutions.

4 CAX Preparation Methodology and Tools

As discussed in sections 2 and 3, the data that is utilised by the exercise environment is critical to the success of an exercise. It represents a considerable investment in time and effort on the part of the CAX data management team and of the nations and headquarters that have contributed to its population, verification and validation. Hence a formalised process is required to maintain the quality of the CAX data and tools are required to support its phases. Paragraph 4.1 describes a process that has been refined in recent years.

Equally paramount in the development a CAX is to ensure that headquarters can use their real world command and control systems. This requirement imposes constraints on CAX databases. It also implies the co-operation between diverse organisations managing exercise environment and day-to-day operational environments. Paragraph 4.2 describes an approach that has been applied successfully in ACE and that enabled complex and sometimes conflicting issues to be resolved in a timely manner.

Finally, the success of an exercise is highly dependent on the level of proficiency of its response cells in performing their part as role players, tasking and information management teams and simulation operators. Paragraph 4.3 addresses some of the issues related to response cell training and some of the approaches that have been pursued with varying levels of success.

4.1 Data base preparation

As discussed in section 3, the JTLS model does not contain data. Hence the population, maintenance and evolution of JTLS databases need to be a sustained activity. As forces re-organise and system capabilities develop, new entities need to be included in exercise settings and suitable system characteristic representation in the simulation database needs to be ensured. The task of data management is likely to become even more critical as simulation interoperability starts to deliver effective federations of simulations.

User ownership of data and the explicit need to invest time and effort in verifying and validating the quality of data used for exercises are at the centre of the organisational approach that has been developed by NC3A for ACE. Indeed the diverse nature of NATO forces, systems and tactical employment concepts, requires the involvement of experts of each nation in various military fields. As these activities require experts to allocate time to perform data collection and verification tasks and to travel to participate in validation efforts, it is necessary for authorities to recognise the need for the investment and to prioritise associated time and funds.

For each exercise, a CAX data base management team (DMT) is formally constituted prior to the initial planning conference. The typical composition of a DMT is listed below:

(1) A DMT co-ordinator provided by the headquarters that has the lead in planning the exercise. The role of the co-ordinator is:

(a) to ensure the participation of all data providers in the data base building process by calling the various meetings and verifying agreed attendance;

(b) to maintain an overview of the contents of the database and ensure that the conditions are being created that will support the achievement of stated exercise objectives. Of particular importance are the force ratios that are established, the capabilities of selected systems and the existence or lack thereof of specific high interest capabilities e.g. theatre ballistic missiles.

(c) to verify the joint aspects of the data base i.e. the complete force compositions and the respective strengths and weaknesses of services and sides which will lead to the need to co-operate during the execution of the mission;

(d) to co-ordinate the representation of non-military entities.

(2) For the selection of all air assets for all participating sides in an exercise, the responsibility is attributed to a representative of the air component command that is usually part of the exercising headquarters.

(3) A maritime and marine forces representative usually provided by the participating maritime component headquarters is responsible for the selection of all related assets including maritime air assets and ground-based sensors.

(4) A geographic data co-ordinator responsible for collecting the data that is necessary to develop the terrain data base

(5) A target co-ordinator responsible for all fixed targets represented in the exercise database.

(6) A representative of each major military formation that is represented in the database and that will be providing a response cell during the exercise. In-depth involvement of the formations in the database building process ensures that the capabilities of forces are suitably represented and validated. This approach prevents many problems that have been encountered in the past when the level of involvement was very limited and response cell personnel identified data inconsistencies in the final pre-exercise preparation phase. The formation representatives will call on support from specific subject matter experts and will assemble a validation team that participates in the validation phase.

(7) As most exercises are set in a fictitious context, a country-book representative is appointed to be part of the data base management team. The role of this representative is to ensure consistency between country book descriptions and data base contents. Active participation by the representative is particularly important in the early and final phases of the database building process.

Concerning the unit database building aspect, a side-orientated organisation of the database management team has been abandoned because it led to imbalances in side strengths and capabilities, which were incompatible with exercise objectives.

The establishment of a permanent data base management has been suggested to reduce exercise-specific data base building activities. ACE’s northern region is investigating the possibility to form such a group. The provision of exercise independent funding for this task may be a challenging issue and may need to be addressed from a more structural perspective. Indeed the establishment of an exercise data management organisation within the headquarters structure may be required to ensure sustained personnel and information systems support.

Over the last five years a process has been developed that consists of five distinct phases:

(1) An entity design phase, which covers approximately four to six weeks and starts approximately 9 to 12 months before the intended execution date of the exercise. Typically this phase will start after an initial planning conference has taken place.

(2) 2 data collection and verification phases. Each phase lasts for about 4 to 8 weeks. The phases are consecutive in time and start after the conclusion of the entity design meeting.

(3) a data validation phase, which covers 4 to 6 weeks. It follows the conclusion of the verification phases.

(4) a Startex validation phase which covers 1 to 2 weeks and starts approximately 6 weeks prior to the start of the exercise. Indeed all the important aspects of the exercise need to be well defined to make this phase effective.

The entity design phase starts with the formal appointment of representatives to the data base management team. Following some introductory briefings on simulation capabilities, the need is described to make a number of decisions concerning the modelling of the natural environment and of the entities that will populate the simulated world. Based on the NC3A team's understanding of the stated exercise objectives, a proposed set of entity designs is compiled and distributed to the DMT members. The phase culminates with a two-day meeting, whose objectives are:

(1) To refine the main database building decisions: detailed decision on geographical area and important features, number of sides, factions within sides, size of force and type of organisation, level of detail of forces and non-combatants, logistic concepts, C2 systems that will consume exercise data

(2) To conduct an initial review of the forces, target sets, unit types and logistic categories that exist in the core CAX database and in the archive of specific exercise database. These data sets are commonly referred to as "shopping lists".

(3) To re-visit and assign the specific responsibilities of each individual DMT member.

(4) To review and amend the data base building time line in order to ensure that it is synchronised with the participating headquarters operational planning process and to complete the process in time for Startex validation and for response cell operator training. The synchronisation with the operational planning process is critical to ensure that capabilities that may be identified as essential to the success of the selected course of action are actually suitably represented in the simulation's database.

(5) To identify areas of uncertainty in the definition of the exercise setting. Indeed the exact detail of exercise requirements may not be fully clarified at this stage of the exercise planning process. Ensuring that these design questions are identified and resolved early, is essential to achieve a successful exercise.

(6) To present the tools and data exchange procedure that will be used to exchange data between data providers and data base builders.

DMT members, representatives of host nations and the NC3A team of simulation and database experts need to participate in the design meeting. In order to facilitate the decision making process, it is necessary to limit the attendance of this meeting.

The decisions taken during the entity design meeting are fully documented including their rationale. The resulting document serves as a permanent guideline for data providers during the database building process. It is also very instrumental during the training of response cells. Indeed learning a simulation's functionality allows an operator to interact effectively with a simulation model. However understanding the reasons that have led to the representation of specific entities and capabilities, enable operators to use them actively to perform their tasks in a way that supports the implementation of the objectives of exercising headquarters.

Following the completion of the entity design document, a scenario database is initialised and distributed to DMT members for extension during the first data collection phase.

The success of the approach described above is closely related to the development of a reference or core data base and of an exercise data base archive. The core database contains verified and validated sets of units and system parametric data. The archive enables terrain and target databases to be re-used. Extensive re-use of data allows the process of database building to be tailored. Particularly the validation phase can be skipped when new system capabilities are not introduced in the exercise database. However data base preparation cannot be compressed too much. Several feedback phases of data and the Startex validation phase are essen-

tial elements in ensuring that exercise requirements and the means to achieve them are understood to a sufficient level of detail and have been configured to achieve an effective exercise.

The data collection and verification phases are organised as a sequence of:

(1) Data collection by the various DMT members

(2) Provision of collected data to data base building team for consolidation and interpretation

(3) Verification meetings between data base building team and DMT members to evaluate progress and identify remaining open issues.

The first phase of data collection focuses on ensuring that all relevant entities are identified and built. During the second phase, the detailed status of entities is emphasised, system characteristics are reviewed in a static manner. The consistency with country books is also verified at this stage.

The product of these phases is usually a database that contains all the entities that were agreed during the entity design phase and that enables the exercising of the outcome of the operational planning process. Experience has shown that it is advisable to develop a more robust force structure for all sides in an exercise setting to increase the ability to respond to late requests by operational planners and to be able to address emerging exercise aspects.

In order to facilitate the distributed data collection and verification, simple unit force structure creation, editing and documentation tools have been developed. They support DMT members in selecting and configuring the part of the force structure for which they are responsible. The tools have been designed to enable the data base builders to consolidate the data base inputs with limited manual intervention at their regular place of work. This approach is considerably more efficient than a paper or electronic form-based approach and is more effective because it reduces the error associated with multiple persons manipulating the same data item. Similar tools have been introduced for building terrain and static targets.

Having completed a static building and review process, the DMT can be assured that the simulated environment and entities have characteristics that correspond to their real-world equivalents. However the ability of entities to interact with each other and with the environment and the associated results cannot be verified by studying the characteristics in a static manner. A dynamic validation is required to address these issues. During this phase, the combination of simulation and exercise-specific data is subjected to a set of detailed tests. The validation phase consists of the following steps:

(1) Definition of test plans. A set of detailed tests has been developed to address each function that active entities need to be able undertake. Tests that are relevant in the context of the exercise are selected and suitably customised for the exercise database. As simulations and entities evolve in terms of capabilities, additional tests are regularly introduced.

(2) Assembly of test teams. DMT members assemble teams that have the necessary knowledge to assess the results of the tests. Reference performance data is also collected to support an objective calibration of the simulation database.

(3) An optional step, which has been very successful when we have introduced new capabilities, has been a pre-user validation session with simulation developers and external simulation data base experts. The ability to step through the events in the simulation at the simulation code level, provides a detailed understanding of the behaviour of all the entities that are involved in a test and allows the identification of the important factors that contribute to the achievement of a particular outcome. Including external data base experts during these tests enables a very effective exchange of experience and insights in the configuration of data to achieve expected results.

(4) Conduct of validation tests. Typically these tests are organised by functional area. They are conducted in a centralised manner bringing together database and subject matter experts.

Participants need to be trained in operating the simulation environment. Experience has shown that this requirement is not always met. It introduces delays in the validation process and increases the burden of analysis by the introduction of a higher frequency of operator error. Depending on the progress that can be achieved during these sessions of approximately 2 to 3 days, it may be necessary to repeat validation tests and to introduce an additional session. Documenting the test process in an effective manner remains a challenging activity especially when attempting to capture reference data also.

The product of the data base validation phase is a database that contains environment and entities that correspond to their real-world equivalents and are able to behave as such in the simulated environment.

In order to improve the quality of data, experiments have been performed with distributed data validation. Small-scale versions of simulation environments have been provided to headquarters in conjunction with training and test plans. Varying levels of success have been achieved principally due to the amount of effort available for local testing and due to the additional system management burden placed on local support teams. In order to alleviate this latter problem, a port of the JTLS environment to a Windows NT environment has been started.

An improved set of test definition, execution and documentation tools are under development.

The final phase of the database building process is the starting situation, or Startex, validation phase. The DMT members and the principal operational planners are brought together to attempt to predict the flow of the exercise. Obviously in a dynamic interactive simulation, the detailed flow of events cannot be predicted. However from a macro-level, the starting conditions should set the scene for the probable direction of the exercise and should enable exercise planners to introduce those elements that contribute to the achievement of the exercise objectives. This phase consists of the following steps:

(1) Detailed Startex setting. Operational planners are requested to describe the intentions and expected implementation of their plans and to set the detailed starting conditions in terms of force positioning, attrition levels and other starting conditions.

(2) Simulation of exercise flow. The exercise planners and DMT members confront the selected plans to the intended activities of other entities and particularly of potential adversaries using the simulation environment with aggregated order sets and at a very accelerated time speed. Several iterations are usually required to achieve a satisfactory starting situation.

The validation session is usually held at a central location or at the primary headquarters location and covers a three-day period. It enables a good assessment of the exercise starting conditions and forms the basis for the CAX management efforts during the execution of the exercise. In order to facilitate the generation of aggregate order sets, tools have been introduced that allow sequences of orders to be defined and executed without manual intervention.

The approach and tools described above have been refined over the last five years and have for the last three years produced consistently well performing data bases in the JTLS environment. Further efficiency improvements are possible as well as effectiveness enhancements, however it needs to be pointed out that data base development is a process that follows and stimulates the exercise design process and as such cannot be excessively compressed in time.

4.2 CAX-CCIS Architecture

An important operational requirement for headquarters collective training is the ability to employ the operational communications and information systems tools that support the operation of and between headquarters. This ability is often referred as “train as you fight” or “train as you operate”. Fulfilling such a requirement implies close co-ordination between exercise and CIS planners. Indeed the CAX and CIS architectures need to be designed and configured as a seamless environment for the exercise to permit the effective trans-

fer of data in both directions. The need to meet security regulations must also be addressed and suitable provisions need to be made to ensure confidentiality of exercise and real world data.

In order to manage the joint CAX-CCIS architecture design and implementation process, NC3A has introduced the concept of a CAX-CCIS architecture group. The principal CIS planner for the exercise leads the group. Representatives of all participant headquarters contribute to the group. In order to ensure the support of the CCIS support organisations, they are requested to participate actively. NC3A acts for NATO as the management organisation for the set of tools that mediate between simulation environments and NATO command and control information systems.

The architecture group has an important configuration management function in the sense that it needs to determine at an early stage of the exercise planning process which versions of information systems will be used by headquarters and which operational communications networks can be employed to support CAX-specific and operational exercise data. Version management applies to the introduction of new releases of simulation environments, mediation-ware and C2 applications. The selection of the versions needs to be taken into account during the database building process. Indeed the exercise database needs to take into account any data-related constraints that are imposed by C2 applications. Otherwise the applications will not be able to be initialised with exercise without a considerable amount of conversion effort. The data constraints apply to the complete range of data sets that are developed for an exercise including terrain, targets, units and system performance characteristics. Close co-operation between data base builders and C2 application designers is the most effective manner to identify the complete set of data constraints.

During the preparation phase of an exercise, modifications and potential enhancements to mediation modules are identified. They may be necessary to leverage new simulation capabilities or new C2 application functionality. Enhancements are implemented if the architecture team assesses that there is sufficient effort and time available to perform the following steps:

(1) Develop a detailed design of the required features. The operational users of the C2 applications as well as their technical support organisation need to work with the NC3A development team to perform this task. Inevitably priorities will need to be set.

(2) Implement prioritised features

(3) Perform technical testing of the modified mediation features. These tests involve the NC3A mediation-ware development team and the technical support organisation of the particular C2 application.

(4) Perform operational testing. Using preliminary versions of the exercise database, the technically tested features are submitted to an operational evaluation. Typically a number of representative and relevant situations will be executed with the complete simulation, mediation and C2 environment.

(5) Produce and submit modified security accreditation documentation. This step needs to be scheduled carefully in view of the timelines that are needed by accreditation authorities to study new features and to grant their approval.

(6) Prepare training material for response cells and operational C2 application users. Indeed mediation-ware may require specific rules to be adhered to in order to perform its function. This is particularly the case for mediation ware that interprets plans and transforms them into a set of simulation orders.

The aspects of mediation that need to be considered are:

(1) Initialisation: the ability to transform relevant simulation data base data into the appropriate format that can be used by the C2 application.

(2) Reporting: the ability to extract relevant data from the simulation environment to provide status or event updates. Typically this form of mediation is achieved through messages that comply with prescribed formats or through database to data base updates.

(3) Ordering: if the plans that are developed by the headquarters are sufficiently formalised in the supporting C2 application, the potential exists to employ automated mediation to transfer these plans into orders that can be executed by the simulation environment.

Currently, the mediation-ware that is used for most major CAXes employs the Joint Theater Level Simulation as its principal data provider and consumer. In order to increase the flexibility and modularity of the mediation architecture, a model independent information exchange layer called the Operational Environment Simulation (OES) database has been defined. Through a number of clients, simulation data is entered into and extracted from the OES database. The OES database encapsulates the JTLS model. Hence any environment capable of generating and consuming the data contained in the OES database could be employed to support the current information flow. A formal report generator, a Maritime CCIS (MCCIS) mediator and a set of Initial Combined Air Operations Centre (ICC) modules complete the mediation process.

The actual mediation-ware that is employed during an exercise is primarily dependent on the level of utilisation of the C2 applications within the exercising headquarters

4.3 Response cell composition, training and tools

Response cells are a major cost driver for exercises. They also constitute a critical success factor. Hence the challenge of the exercise planning team is always to achieve the greatest cost-effectiveness by designing cells that are affordable in size, that have the appropriate composition and that do not require an excessive amount of time for training.

Several approaches can be considered with different merits and associated cost-effectiveness:

(1) Full augmentation: cells are fully manned by augmentation personnel supported by one or two simulation experts. This approach is usually applied for large exercises that are executed on a 24-hour basis with response cells operating from various distributed locations. In order to transfer the knowledge that is necessary to operate the simulation environment effectively to the large number of augmentation personnel a three-step approach has been applied successfully. The first step consists of a one-week familiarisation with the simulation. Formal briefings and hands-on sessions are alternated followed by a mini-exercise. A scenario is used that is not necessarily related to the exercise. The second step is a two-week train-the-trainer session. During the first week, response cell trainers are instructed in the detailed operation of the simulation using the database that will be employed during the exercise. During the second week, the focus is placed on how these trainers will convey their knowledge to the rest of the augmentation personnel who will form the response cell during the exercise. The third step is response cell training just prior to the exercise. As a result of experience, this phase comprises an operator training phase of three days, 1 day of operator mini-exercise and two-days of complete response cell mini-exercise. The exercising headquarters do not participate in the mini-exercises to avoid confusion and to be able to focus on response cell objectives rather than staff goals.

During the last three years, the limited simulation environments that were installed in headquarters to support the validation of the exercise database have also been employed by response cell trainers to train augmentation personnel from their headquarters. Cells that were prepared in this manner displayed a considerably better performance than other cells.

(2) Mixed professional operators and augmentation: this approach combines professional operators who manage and task entities with augmentation personnel who are able to retrieve relevant data and who monitor progress in the simulation. It has been applied very successfully for small-scale exercises where a limited number of operators are capable of managing the entities

that are active in the simulation. Due to their background, training of professional operators is not required. Augmentation personnel are principally instructed in data retrieval tasks and monitoring tasks environment. A three-day session prior to the exercise is employed to convey this knowledge. The final preparation that precedes the exercise serves primarily to introduce the operators to the exercise database and scenario and to perform a 1.5 day operator mini-exercise. During this dedicated mini-exercise, the important phases of the expected exercise flow are executed. Finally a one-day mini-exercise is executed with the complete response cell including the planning and reporting element that does not need to interact directly with the simulation environment.

It must be noted that the term response cell used above applies to all exercise control components including directing staff and other forces cells.

Experiments have been conducted during exercises with automated tools capable of performing order amplification and information aggregation to investigate potential reduction in training time and complexity and to study reductions in cell size. Due to the technical complexity of these tools and limited development resources, work is continuing in this area and experimental results have not yet been conclusive. Powerful data visualisation techniques, algorithmic approaches and artificial intelligence-based concepts are combined to develop these capabilities.

5 CAX Conduct

5.1 CAX-C2 mediation

NATO information flows make extensive use of formal reports formatted in accordance with published specifications (Bi-SC reporting directives, AdatP3, local directives). The Formal report generator combines data from the OES database with format definitions to create text files. Depending on the physical implementation of the link between JTLS and the HQ's messaging system, reports can be emailed to selected stations or passed to a military message distribution system. If required, the message header can comply with the ACP127 format, enabling distribution based on Subject Indicator Codes.

Report Generation can be triggered in three ways:

1. Periodic Reports. The report is automatically produced at specified simulation times.

2. Event based reports. The report is produced when a certain event happens in the simulation e.g. the detection of an enemy unit

3. Requested reports. The production of a report can be triggered manually by entering its type and originator at the report generator workstation.

It must be noted that only factual information can be drawn from the OES database and the simulation model. Report fields that require human judgement or assessments cannot be produced. Response cell personnel need to add this data. Also, some factual information may not be available from the model such as the primary and secondary task of a unit, its echelon, its OPCOM/OPCON status etc. The most effective use is for response cell to edit the reports and add relevant data. If messages are automatically passed to the C2 systems, these missing data items will appear blank (or some default value) in the CCIS system's database.

The JTLS-MCCIS Mediation-ware is an example of an implementation where formatted messages produced by the report generator are sent to and automatically processed by a CCIS system. OTH GOLD contact reports are sent at regular intervals to MCCIS causing the Recognized Maritime Picture (RMP) to update its set of simulated tracks automatically.

In addition a utility exists which can convert a JTLS user line file into an OTH GOLD overlay message (OVLY). Response cell created graphics can be passed to an exercising headquarters' MCCIS as an overlay to convey additional information.

ICC is an integrated C3I environment that provides information management and decision support to NATO Combined Air Operation Centers (CAOC). The ICC provides functional support for the most critical Air C2 functions at the CAOC level, such as Planning & Tasking, Air Task Order (ATO) and Mission monitoring.

The ICC – JTLS Mediation-ware provides the CAOC's the possibility to use their own C2 System during JTLS exercises. The mediation-ware is bi-directional. Data is retrieved from ICC into JTLS (tasked missions). JTLS data is inserted and updated into ICC (e.g. mission reports).

The ICC – JTLS Mediation-ware contains 4 modules:

(1) ICC Initialize module: This module extracts relevant data from the JTLS scenario database and translates it to the ICC database e.g. aircraft characteristics, air defense sites, radars and (enemy) targets are stored in an ICC exercise database.

(2) ATO compiler: The CAOC's plan an ATO in ICC. Once released, the ATO compiler translates the ATO from the ICC format to JTLS orders. These orders flow into JTLS.

(3) ICC update module: Once a compiled ATO is read into JTLS, data can be sent back to ICC. Mission flight information, reports and analysis as well as status of squadrons, airbases, air defense and radar sites can be kept updated in ICC.

(4) ICC track Formatter: JTLS track data is transformed and sent to the ICC workstations enabling a Recognized Air Picture (RAP) to be shown on ICC's ADAPI tool. A link exists between tracks and mission data to enhance RAP monitoring.

Several methods can be distinguished to pass information from the OES database to a CCIS system:

(1) Direct database to database connection. In this method, an interface process copies data directly from tables in the OES database to tables in the CCIS system's database. This is done in the case of the ICC interface.

(2) Formatted messages, automatically parsed by the receiving CCIS system. Data from the OES database is formatted according to specified rules and transmitted on a designated channel (email, tare, direct connection) to the CCIS system where it is automatically processed. The MCCIS interface is an example of this method.

(3) Formatted messages, parsed by operator intervention at the receiving CCIS system. Similar to the previous method but an operator has to take some actions to absorb the information in the CCIS system.

(4) Formatted messages only.

In addition to a data base driven approach to mediation, NC3A and the US Defense Modelling and Simulation Office (DMSO) have developed a mediation solution for JTLS, to communicate with ICC, MCCIS and the report generator according to the specification of the High Level Architecture as shown above.

The mediation-ware has been refined over the last 4 years. It has allowed the size of air response cells to be reduced and has greatly contributed to the refinement of headquarters way of using C2 applications by enabling their utilisation on a scale and intensity that cannot be achieved through other means.

The impact of using direct interfaces between simulation and CCIS is the need to have greater validity. Indeed, discrepancies between simulation and real world become almost immediately apparent to the training

audience e.g. an automated maritime picture display is updated automatically and will show the disappearance of a ship in an almost real time manner. Hence it must have a valid explanation. With the growing formalism given to instructions between headquarters and subordinates in C2 systems, prototype interfaces have been developed by NC3A that are capable of transferring these orders into the simulation environment without manual intervention. Work in this complex area is on going.

5.2 CAX management

From an organisational perspective, a method has been developed and applied successfully that turns the team that has prepared the exercise database into the CAX management cell for the exercise. Indeed these persons combine a deep knowledge of the exercise objectives, of the courses of action and expectations of operational planners, of the simulation model and of the simulation data that has been engineered to support the achievement of the objectives. Co-located with the core of the directing staff they can monitor exercise progress and advise on any immediate or other important exercise control decisions.

One of the tools that are regularly employed for exercise control co-ordination is Video Tele-Conferencing. (VTC) Following a formalised cycle of meetings, typically two per day for 24-hour exercises, this method of distributed meeting has proven to be effective. The main factors that contribute to its success are the high degree of co-operation that the tool promotes through its increased information content compared to a telephone conference and the need to confer in an organised and disciplined manner. The objective of the VTC meetings is to address exercise control issues from an exercise operational and from a technical perspective. The leaders of all the exercise control cells participate in the meetings and contribute their impressions. This approach enables a strong team spirit to be achieved even though members are distributed over large distances.

For the management of more detailed questions that are raised by members of exercise control cells, a procedure of electronic mail exchange with the CAX management cell has been developed. This approach is to be recommended over other approaches because it enables the following essential CAX management aspects to be addressed in a very efficient manner:

(1) When reporting a suspected issue or problem, cell operators have the ability to cut and paste actual simulation data into their message. The CAX management receives the detailed information that it requires to investigate the reported problem and can respond with an equal level detail. Compared to a telephone, note taking and third person input into a problem management tool, this approach offers great advantages.

(2) Messages can be organised by sending cell and sub-organised into open and closed items. Most modern messaging environments support the management of message flows using custom folders. Furthermore timeliness of responses can be tracked and responses that may be of interest to multiple cells can be propagated very easily.

(3) The level of importance and criticality can be indicated in a message characteristic or subject header enabling rapid selection and retrieval by members of the CAX management cell.

(4) Finally CAX management team members do not need to react in real time to incoming requests in a way that is required when problems are reported using telephones. This efficiency gain is quite considerable.

Although having instituted an effective method to manage and act upon reports of suspected problems is critical, CAX management can be greatly improved if problems can be anticipated, studied and remedied before they become apparent to the exercise control cells. Obviously the overall objective is to ensure that problems, either real or perceived, do not become apparent to the exercising headquarters. The most important classes of reported problems are either related to parametric data or to events being considered as inconsistent with exercise objectives or as an unfair usage of simulation features. In order to address this problem domain, NC3A has developed and experimented with a set of tools that monitor simulation events and pro-

vide aggregate views of the state of the simulated world. Concerning the monitoring of critical events, exercise experimentation has shown that perceived problem issues are often related to two areas:

(1) High levels of attrition over a very short period of time: important losses to army formations over short periods of time can impact the execution of the course of action selected either by the exercising headquarters or by the exercise control cells responsible for other forces than those managed by the exercising headquarters. The CAX management cell has been equipped with a number of views that depict losses over time and sort them by most important victim over a selected time frame. These tools have enabled the CAX management cell to become aware of the impact of losses more rapidly than the cells that are actually managing the forces.

(2) Attrition to high value assets: typically in the airforce and maritime areas, assets which are considered and perceived to be highly unlikely to be the subject of attrition by exercise control personnel are monitored by class. Attrition is flagged instantly and associated causal data is assembled in a processed form.

Combined with an ability to analyse the reasons for the attrition, an assessment of the causes can be made rapidly. Potential courses of action can be evaluated and acted upon before the problem is actually raised by the cell that is managing the affected forces. The ability to anticipate problems and to provide detailed descriptions of the causes of events, contributes greatly to the stability of the exercise environment.

It should be noted that the close integration between simulation and C2 systems increases the need for close monitoring of events and for the availability of a capability to trace the causes of specific events, even more.

From an aggregate exercise management perspective, a very important step in managing a CAX effectively is the definition of a scenario flow reference. This reference data is built up and validated during the Startex validation session. An expected flow in time and space for the exercise is developed as a result of the session. The flow in time and space is expressed using a set of aggregate measures, which are collected during the exercises. The comparison of intended and actual exercise flow enables the CAX management cell to assess exercise progress from a macro perspective and greatly reduces the tendency to react to individual events. Indeed the intensity of exercises, during which many events that would normally take place over longer periods of time are concentrated and during which carefully laid plans are sometimes gravely disturbed, can lead to a tendency to react very negatively to adverse events. The ability to maintain and visualise the “big picture” is the most effective tool to counter such situations.

5.3 Observation and analysis

Currently observation and analysis from a CAX perspective is primarily focused on the simulation environment. Co-ordinated and combined observation of simulation and operational environment has not yet been addressed although the need to do so is recognised. The tools that are discussed in the previous section and that are very effective for real-time CAX management are currently also the main tools that are employed for after-action analysis.

6 Future Needs

The experience that has been gained through exercises and experiments over the last ten years in the field of CAXes that focus on the operational level of decision making has been discussed in the previous sections. Great methodological and technical progress has been made. However requirements continue to evolve and expand. At the same time, the pressure to use available personnel and financial resources in an ever more efficient manner continues to increase. Together they pose considerable challenges to the developers and operators of simulation environments. This section will discuss some of the technological avenues that might be considered to meet these challenges.

6.1 Simulation composability

Over the last ten years, aggregate simulation interoperability as well as entity level simulator interoperability have developed considerably and have been used for operational exercise support purposes. Many of the problems associated with the utilisation of networks of simulations and simulators are understood. Interoperability protocols for these two domains have been merged in the specification for the High Level Architecture (HLA). Recent experience shows a trend in combining simulations to meet specific exercise requirements rather than expanding individual simulations. A major factor in this trend is the need to combine different levels of detail. As aggregate simulations would need to be modified considerably to provide the required level of detail in some areas and detailed entity-level simulations cannot manage the size and number of entities required for an aggregate scenario, the temporary combination of the simulations appears the most cost-effective solution. For more elaborate confederations in which many different simulations participate, issues of data base preparation, response cell training and exercise management need to be studied further. Concerning the area of preparation, validation of data that is used across simulations and validation of effects of systems needs to be addressed carefully. From a response cell preparation perspective, the training of augmentation personnel needs to be investigated particularly in the case that operators may be interacting with multiple simulations. Finally managing a federation of simulations in a manner that was discussed in the previous section needs to be studied. Indeed it is highly likely that data that is exchanged between simulations will not provide sufficient data to support the exercise control process as discussed in the previous section.

Anticipating meaningful combinations of levels of detail and identifying associated sets of simulations can greatly contribute to the ability to meet exercise requirements within the 12 to 18 month planning cycle of an exercise. Indeed attempting to reduce the amount of time required by the proven technical process of interoperability development and testing to fit within an exercise planning cycle, should not be advocated. The increased technical risk and likely problems and failure during exercises can only detract form utilising this very cost-effective approach.

Further combining interoperable simulations with C2 mediation and intelligent agents capable of reducing exercise control cell personnel requirements appear to be effective avenues.

One of the key factors of success for this type of approach is the commitment of sufficient resources to the management aspect of federations of simulations, C2 mediation and intelligent agents. Indeed the management of interoperability agreements, the certification and testing of federations and the management of their employment needs to be properly resourced in order to provide longer term benefits.

6.2 Advanced Distributed Learning

As discussed in section 4.3 training of exercise control cell personnel is a critical aspect for the success of any computer-assisted exercise. The regular turnover of military personnel requires a continuous approach to training. As pointed out in section 2, this training must start with exercise planners. In view of the distributed nature of the training and the availability of reliable digital communications between headquarters, the expanded usage of computer-based training tools and distributed interactive capabilities needs to be explored and leveraged. Efficiency gains due to reduced travel time requirements and effectiveness improvements associated with more extensive and verifiable training opportunities are the likely benefits.

The same technologies can be applied for augmentation personnel training although the ability to communicate with them may be reduced. Indeed augmentation personnel may not necessarily be reachable through secure digital communications networks. Training across public networks should be considered and investigated.

6.3 Observation data collection and interpretation

Finally an area that remains to be developed considerably is the structured analysis of performance of collective training during CAXes. The process of deriving data collection requirements from exercise objectives

and aggregating group behaviour into representative measures of performance that can support the assessment of a headquarters ability to conduct certain missions needs to be improved and facilitated significantly. In particular it is considered essential that data collection and correlation inside the combined simulation and C2 environments be implemented to achieve this objective. The environments need to be instrumented in such a manner that meta-data can be collected and can be related to each other thus enabling events and problem situations to be monitored from their inception to their resolution.

The provision of an objective methodology and supporting tools to perform effective collective performance measurement is necessary to support the development of training doctrines and standards for NATO headquarters and partner nations.

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CURRENT PRACTICE IN COMPUTER ASSISTED EXERCISES IN ACE

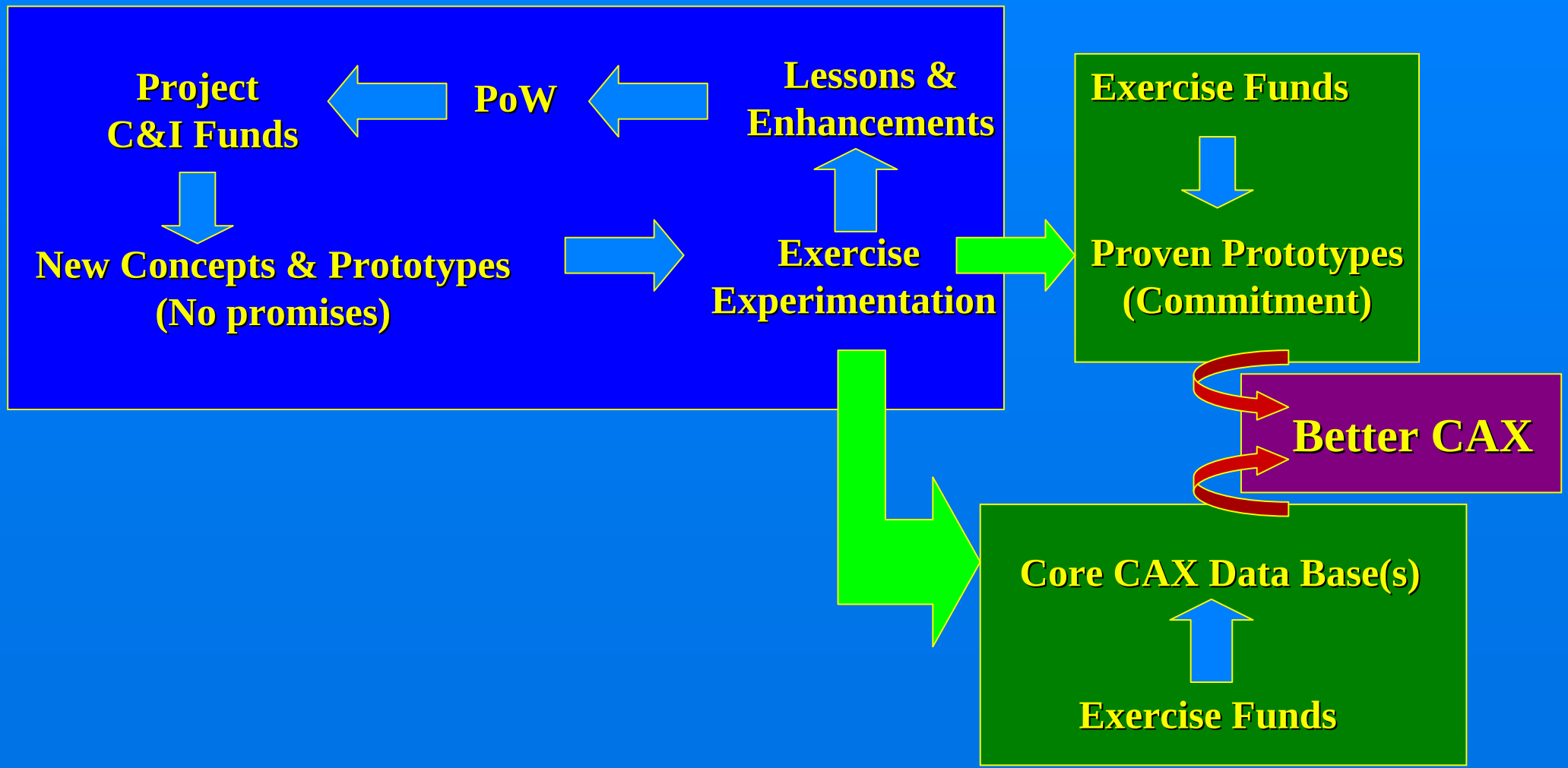
Dr Dirk Coppieters
NATO Consultation, Command and Control Agency

The Role of the Agency in establishing a CAX Capability for NATO

NC3A CAX Project Mission

- Improve current approaches to CAX in Allied Command Europe
- Design a permanent capability for ACE
- Support the acquisition of the permanent capability and support its evolution

Method of Development and Funding



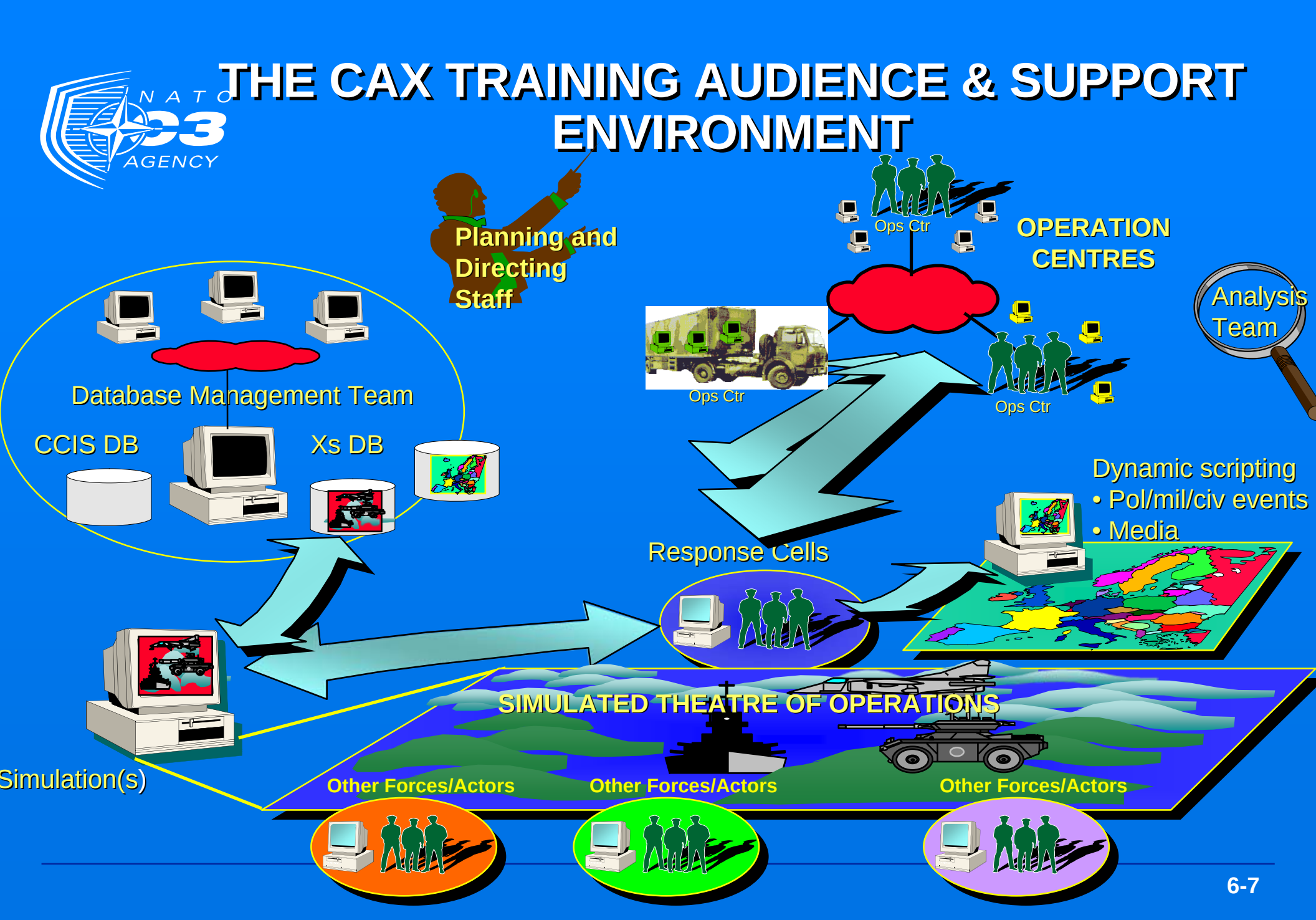
What is CAX ?

Definition of CAX

A Command Post Exercise in which computer-based simulation models are used to place commanders, staffs and their command and control systems in an operationally realistic environment in order to perform decision-making, practice staff procedures and co-ordinate between headquarters.

Source*: *ACE CAX Planners Course

THE CAX TRAINING AUDIENCE & SUPPORT ENVIRONMENT



Critical Success Factors

- **Simulation environment**
  - **Model: Reduction of the world's behaviour**
  - **Database: Entities that populate the model and their behavioural characteristics**
  - **Simulation support organisation: professionals who understand how to use, configure and refine data and models in the users C2 environment**
- **Response Cells & C2 interfaces: People and systems that make the simulation environment seem real**
- **Directing Staff : People who manage all the exercise elements to meet the exercise objectives**

How do we plan, prepare, execute and analyse CAXes ?

NC3A CAX Roles

- Co-ordination of overall CAX design and implementation including technical design
- JTLS employment options and limitations
- Data base building making re-use of ACE CAX Core data base and unit libraries
- CCIS mediation development, configuration and operation:
  - Report generation: JOIIS, MCCIS
  - ICC/ACBA mediation
- CAX management function during conduct
- Analysis of the CAX capability employed for exercises

The current model of choice
The Joint Theater Level Simulation

- Joint Operations: Air, Land, Maritime, Marine, SOF
- Multi-sided and Multi-faction
- Fully data driven
- Logistics and Intelligence impact Operations
- Entities can conduct operations other than war
- Suitable level of resolution for Corps and above, CAOC and above, Fleet and above exercises
- Suitable representation of Special forces teams

- Affordable within NATO manpower and funding
- Good operational reliability

- SHAPE participates in decision making about its evolution

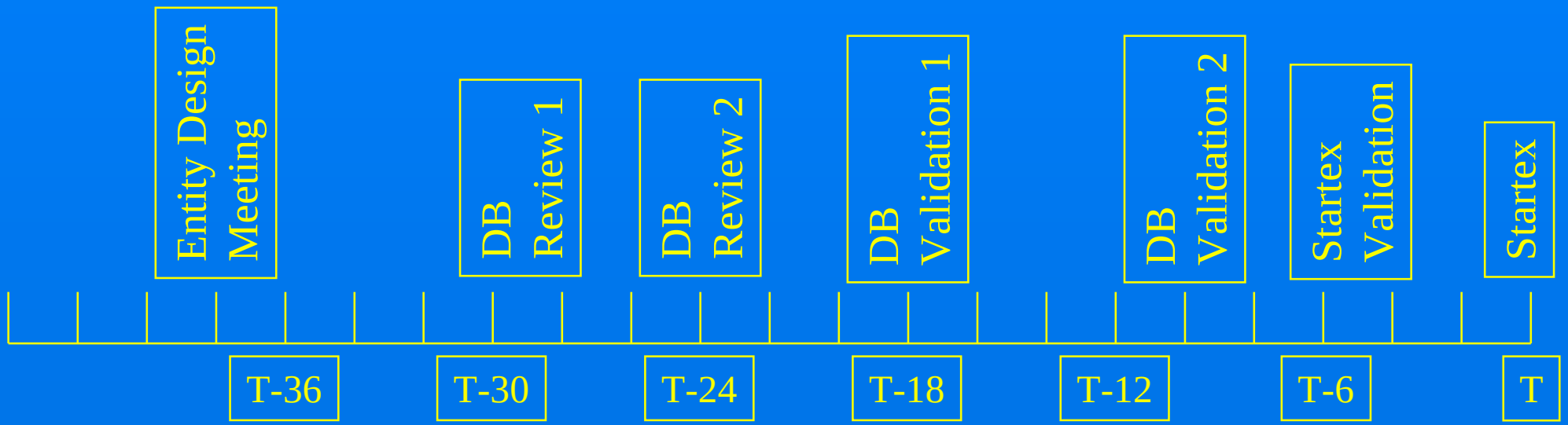
How do we plan, prepare CAXes?

The Process of Data Base Building

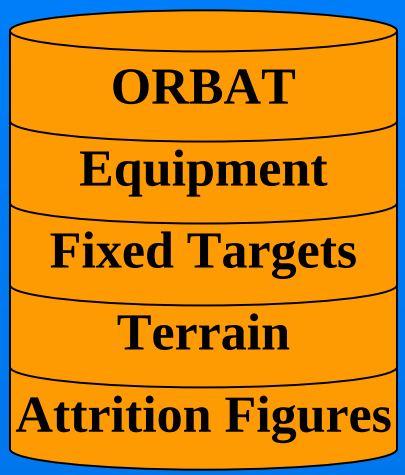
- Form Data base Management Team
- Meet to design CAX entities
- Collect and review: 2 rounds
- Validate: 1 or 2 sessions
- Synchronize with MEL/MIL
- Validate Startex
- Document

Typical Time Lines

Extensive Build - Terrain, forces and complex logistic structure

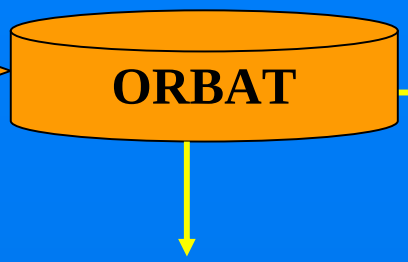


Units - (OE) Orbat Editor



Process

Extraction

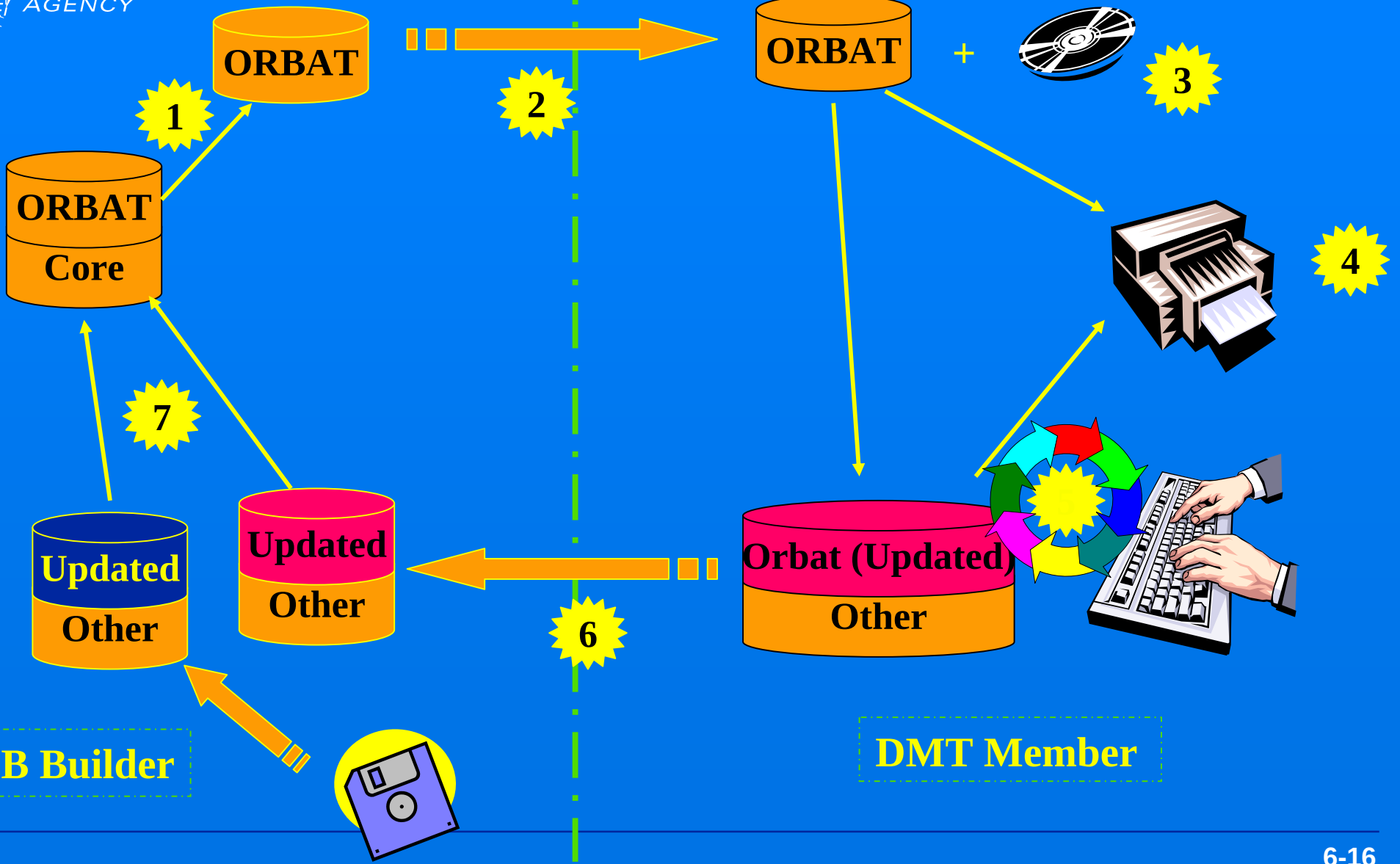


AREA:
- Air Orbat
- GBAD
- Naval Orbat
- Ground Orbat
- Airbase Infrastructure
- Logistics support chain

DATA:
- Unit definition
- Unit Prototype
- Owned targets (SAM, SSM, Bridge,…)
- Command structure
- Support structure
- Comments

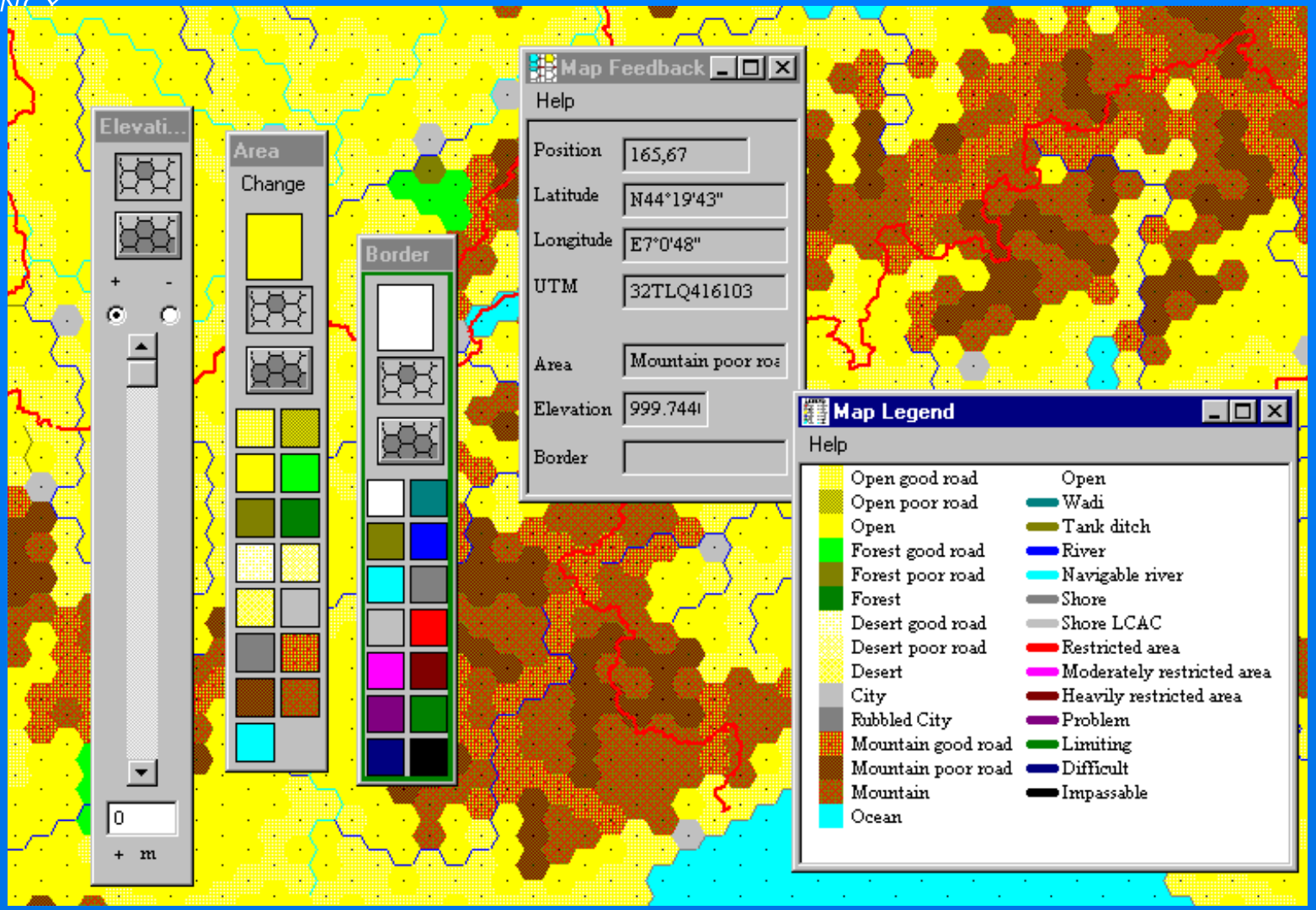
- Pointer to equipment names

OE - Concept of Operation

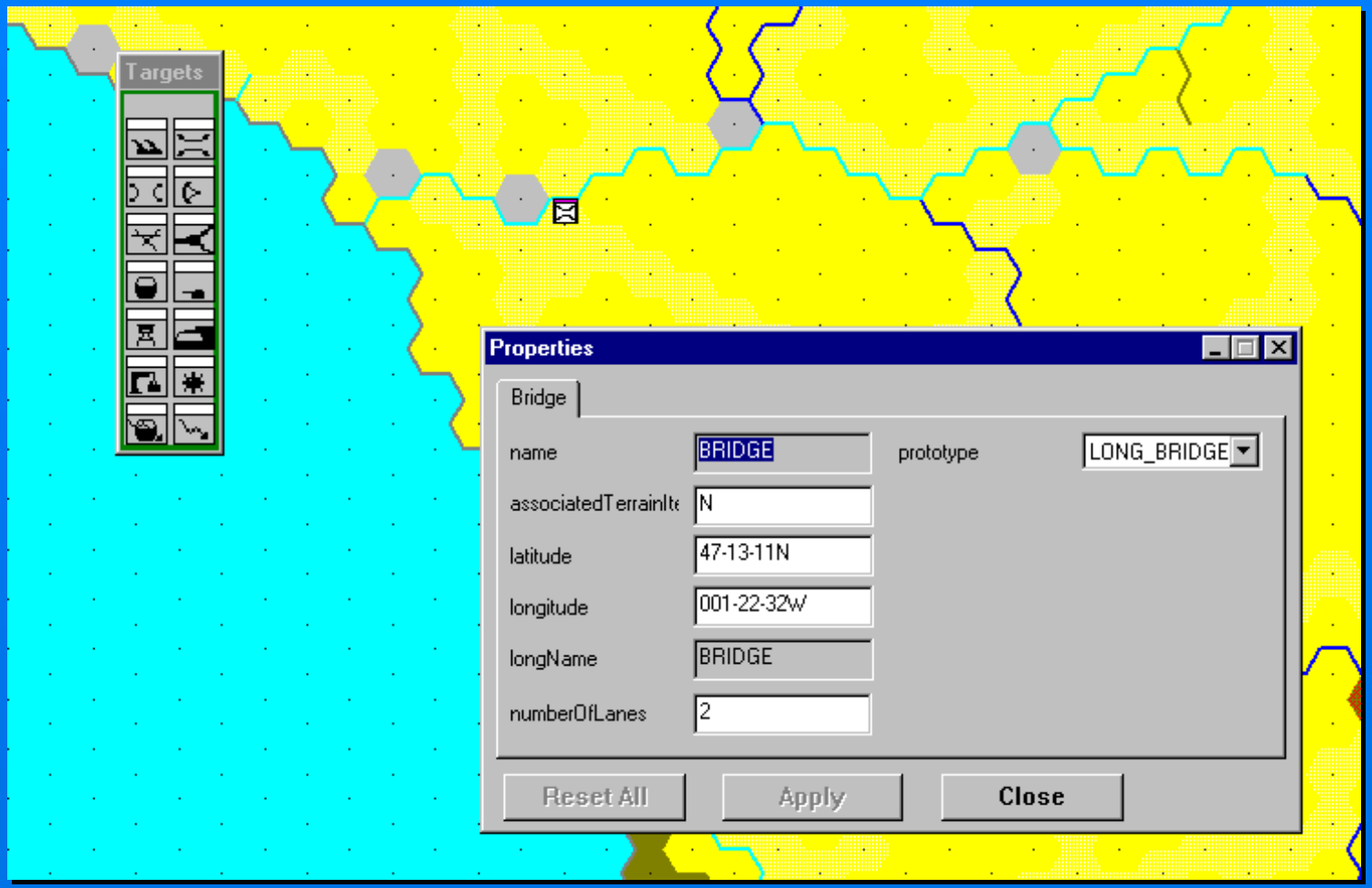


CAX DB manager

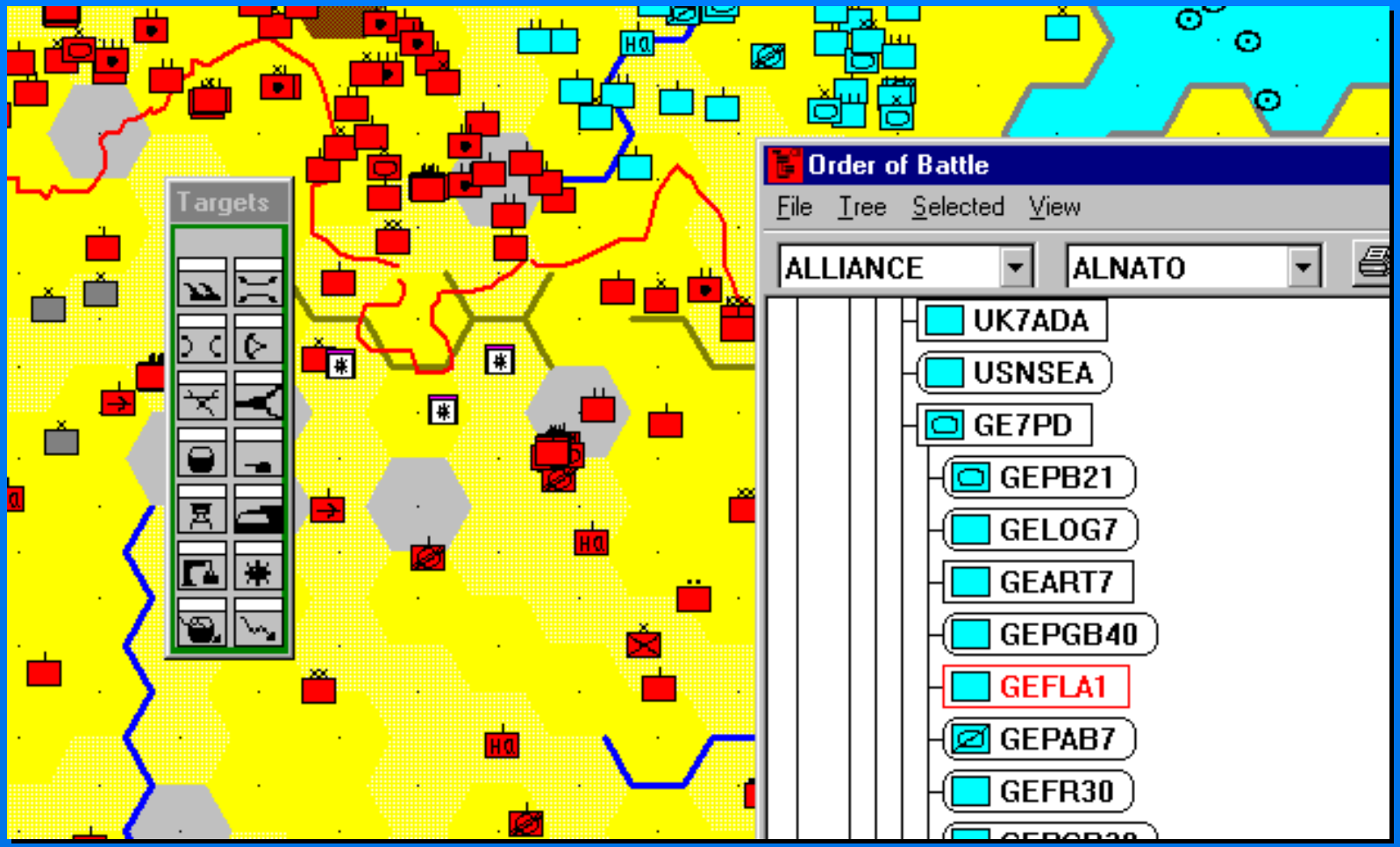
Map and Unit Builder (MUB)



Terrain Infrastructure -MUB

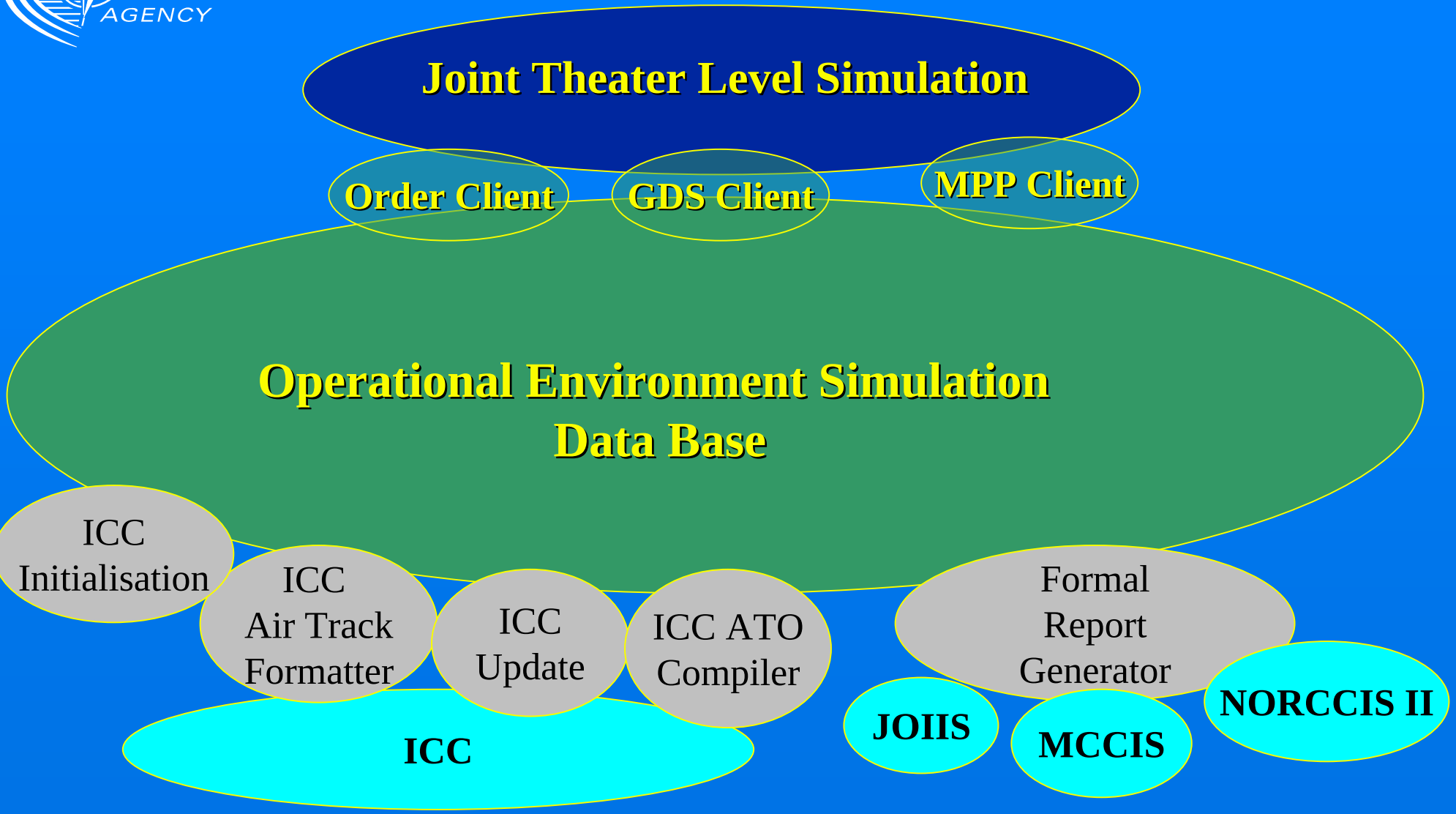


MUB & Startex definition



How do we conduct CAXes?

JTLS-OES Mediation-Ware



Aspects of Mediation

- Initialisation
- Reporting from response cells to primary participants
- Providing direct feeds from CAX into CCIS
- Extracting order data from CCIS
- Receiving messages from CCIS

Aspects of Mediation

- **Initialisation**
  - CCIS data base of terrain, units, targets and other relevant characteristics is initialised from CAX data base to ensure consistent perception of the exercise environment
  - Exercise design issue:
    - Intelligence data should be decided as part of Intel build-up
- **Reporting from response cells to primary participants**
  - Only lowest level of primary participants eligible
  - HQs to define type, format with reference, frequency and source(s) of formal reports as well as messaging system used to send and CCIS that will be processing reports
  - Consider other force(s) requirements

Aspects of Mediation

- **Providing direct feeds from CAX into CCIS**
  - Replicating sensors either raw or fused
  - Air track data
  - Maritime track data
  - Updating CCIS data bases directly
- **Extracting order data from CCIS**
  - Structured plan can be extracted and processed to help RC in implementation of plan
- **Receiving messages from CCIS**
  - PTA sends messages to RCs representing subordinates
  - set up proper routing and distribution in RC

CAX-CCIS Architecture Group

- Form CAX-CCIS architecture group
  - All HQs represented
  - All CCIS technical support and configuration management authorities represented
  - NC3A for CAX and mediation dimension
- Define mediation-ware expectation and requirements
- Develop, amend and test
  - CAX mediation-ware
  - Combined usage of JTLS-Mediation-Ware-CCIS
  - Intended architecture during exercise including security aspects
  - Set up mini-version e.g. at NC3A or at support site
- Manage software versions
- Ensure training of staff in CCIS tools

CAX ORGANISATION AND ROLES

- EXERCISE CONTROL ORGANISATION
  - DISTAFF
  - WHITE CELLS
  - RESPONSE CELLS
  - OPFOR
- ROLE OF EXERCISE CONTROL ELEMENTS
  - MAKE THE EXERCISE WORK TO ACHIEVE OBJECTIVES
  - MANAGE EXERCISE PROBLEMS WITHOUT INVOLVING TRAINING AUDIENCE
- BENEFIT TO EXERCISE CONTROL ELEMENTS
  - EXPERIENCE IN CAX PLANNING AND EXECUTION
  - NO OPERATIONAL/TACTICAL TRAINING BENEFIT INTENDED

WHAT IS THE SIMULATION ?

- The model
  - Uses the data that HQs have specified, verified and validated
  - Doesn't act by itself,
    - Executes the orders that it receives
    - if the orders are syntactically correct, they are assumed to be "good" and make tactical sense
  - Executes the orders that are given by the opposing forces also
  - Moves forward in time
    - Mobile units and targets change position and strength
    - The clock stops for no-one
  - Provides only a perceived view of the situation based on available intelligence efforts and assets
  - Needs to be consistent with scripted exercise events
  - Is controlled by the CAX Management Cell
- Simulation: Model + Data + Interfaces + Response Cells + Opfor + Exercise Control Staff + CAX Management Cell

Managing the model and data as Distaff (1)

- CAX management cell in Distaff
  - Acts as advisor to exercise control director
  - Composed of primary participants DMT members & CAX specialists

- The problem management process
  - Perceived problems are discussed in RCs or other cells with operators
  - if solution cannot be found, e-mail using template to CAX management cell through JTLS workstation
  - CAX management cell consults with Distaff desks and diagnoses problem and develops most appropriate solution
  - solution tested independently to ensure model stability
  - CAX management cell implements solution and e-mails confirmation to problem reporting cell
  - Do not report perceived problem to training audience

Managing the model and data as Distaff (2)

- Anticipating problems
  - During Startex validation session, expected exercise flow documented
    - maritime interactions anticipated in time and space
    - air attrition estimated
    - ground force ratio estimated in time and space
    - with respect to phase of campaign selected for the exercise
  - Tools to track aggregate state of the exercise e.g. force ratios in time and space
  - Tools to track critical events
    - large attrition in short period of time
    - loss of high value assets

RESPONSE CELL
WHAT IS IT AND WHAT SHOULD IT DO ?

- Represent all units subordinated to the Training Audience and its Co-operating Components or Nations who interact with the training audience and who act in the simulation
  - Represent the highest headquarters that receives guidance from the training audience and reports to them
  - Represent the brigade, battalion, company or squad that is actively conducting operations in the simulation and reporting to the cell
- Represent the various staff elements and the commanding officers of the units that interact directly with the training audience
- Part of the Exercise Control Organisation
- Major activities
  - Command and control at multiple levels
  - Report at the highest subordinate level
  - Co-ordinate major actions and reports with Exercise Control Cell

RESPONSE CELL
WHAT IS IT AND WHAT SHOULD IT DO ?

- Implement Guidance and Report In a Doctrinally Correct Manner
  - Command:
    - Translate Orders from the Training Audience into a sequence of plans and a corresponding set of JTLS Orders. Implement doctrinal delays related to C2 cycle
    - Input JTLS orders for execution
  - Control:
    - Keep track of orders
    - Track feedback from units: progress, attrition, speed, results of actions
    - Monitor execution of plans and respond to deviations within your command responsibilities
    - Co-ordinate with other response cells for supporting activities
  - Reporting:
    - Report significant events in a timely manner, build in delays
    - Report status and intelligence as specified by reporting procedures or on request. Implement doctrinal delays related to reporting cycle.

RESPONSE CELL
WHAT IS IT AND WHAT SHOULD IT DO ?

- Co-ordinate with Exercise Control Cell
  - Participate in daily Distaff meetings:
    - brief guidance received from training audience
    - brief plans and status
    - co-ordinate additional injects required by exercise control
  - When unexpected events occur, check with CAX Management before reporting them to the training audience
  - When unexpected requests for information are received from the training audience, check with CAX Management before reporting them to the training audience

Response Cell Support Concepts

- **For small concentrated exercises**
  - Professional operators: available in limited numbers
  - Possibly augmented by limited number of augmentees for data retrieval
  - No or limited training requirement, only introduction to exercise setting and expected scenario
  - Very effective but not cheap
- **For large distributed CAXes:**
  - Combination of professionals acting as cell coordinators and augmentation
  - Considerable training requirement:
    - two phases: Train-The-Trainer and pre-exercise training
    - possible use of local JTLS installation

How do we prepare to evolve CAXes?

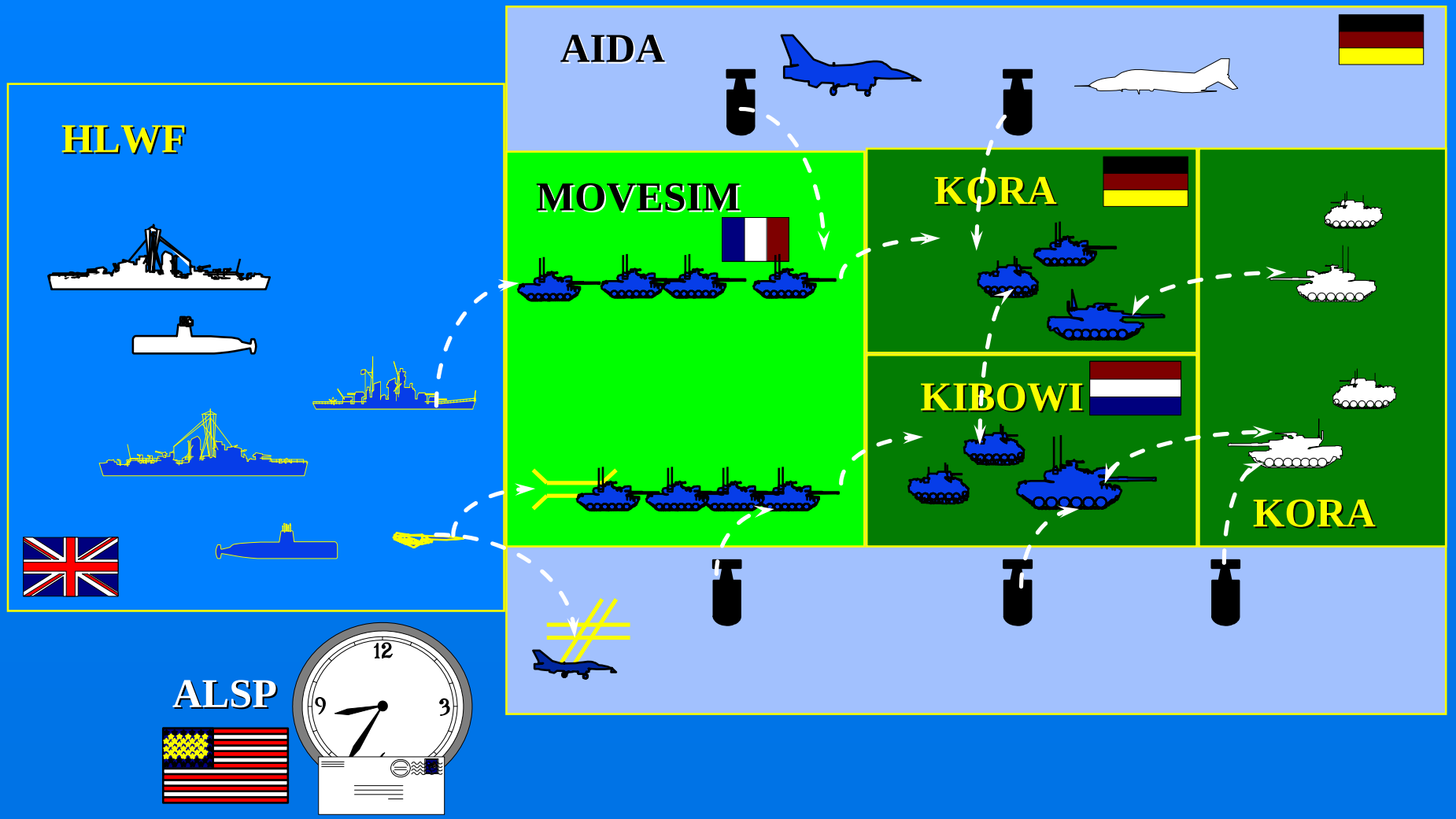
Multi-National CAX Model Interoperability

- **Assumptions**
  - that national models provide the best representation of a nation's forces and of their concept of employment
  - that in the medium term, it is more cost-effective to re-use various existing simulation models and adapt them to interoperate than to develop one or several new simulation models to meet the exercising requirements

- **Research question**
  - Is it more cost-effective to use interoperating national models than a single adapted existing simulation model to simulate the deployment and employment of multi-national formations (air, land and maritime) in a pre-conflict and conflict scenario ?

DiMuNDS 96

Distributed Multi-National Defence Simulation



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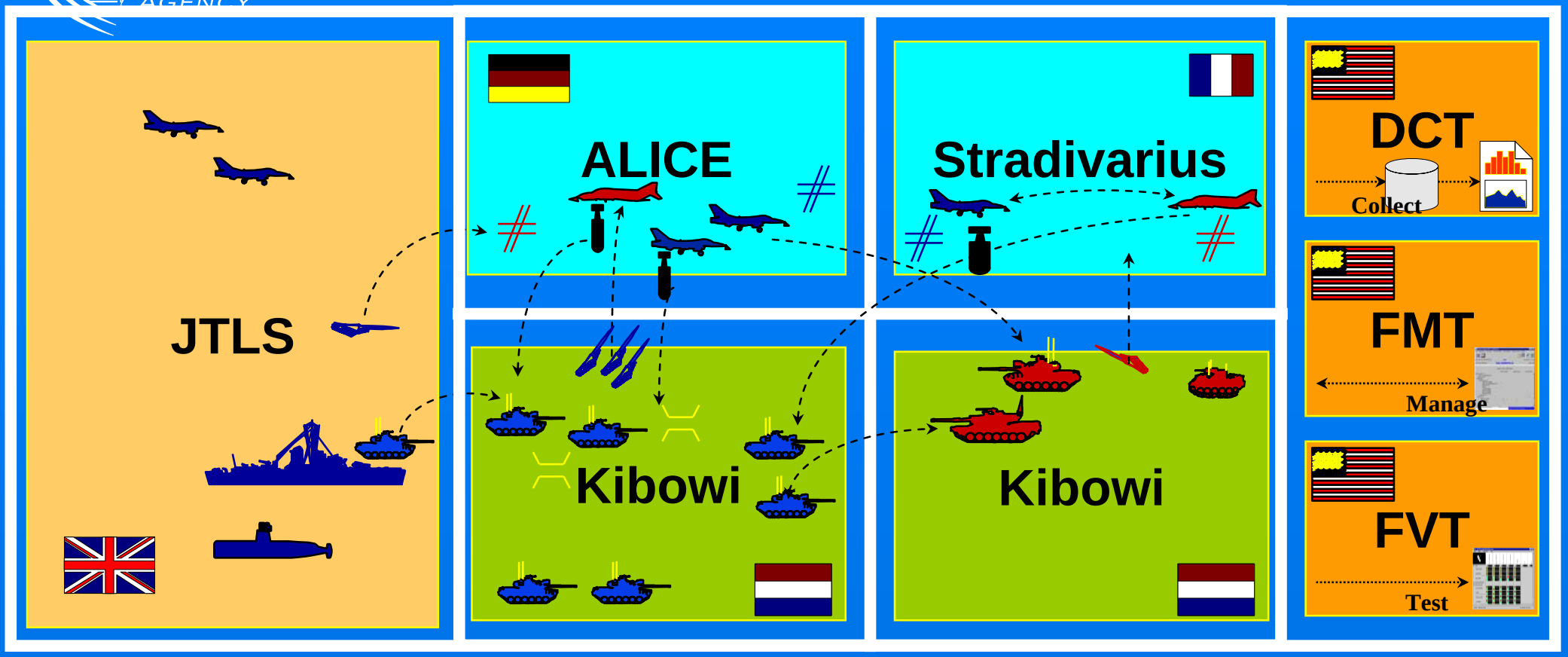
‘DiMuNDS 2000’ Federation



Federation Management:
NC3A –TNO - DMSO

HLA-RTI

Notes for Slide 38

A pictorial representation of the DiMuNDS 2000 federation is shown above.
Ground forces will be represented by two (separate) instances of KIBOWI. Having two instances of the STRADIVARIUS model is also under consideration.

NATO C3 Agency acts as the Federation Manager for the DiMuNDS 2000 project, supported by additional staff from The Netherlands Organization for Applied Scientific Research (TNO) and Virtual Technology Corporation (VTC). The DiMuNDS 2000 federation management effort is jointly funded by NC3A and DMSO.

General Conclusions

- Development relatively cheap
  - Relative to investment in various simulations being combined and cost of included the functionality of one or more into another
- Considerable coordination and management overhead
  - Develop and document interoperability agreements
  - Layout and verify development steps
  - Organise and analyse tests
- Conformance testing essential
  - Tests need to be developed by central authority
  - requires verification by central authority
- Multi-National effort requires full and sustained commitment

Future Needs

- **Simulation composability**
  - Combine simulation strengths and specific characteristics to achieve more
  - JTLS, HLA and existing Federation Object Models
  - Include interoperability with C2 applications
- **Distributed Learning for exercise control augmentation training**
- **Methogologies to measure exercise benefit**
  - Individual learning measurement understood
  - Organisation learning measurement less well defined

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